SUBMERSIBLE PUMP

BACKGROUND

[0001] The present invention relates to the general field of motor-driven pumps, and more particularly to a submersible pump unit, particularly designed to perform submerged in fluids or solutions, especially those comprising strong and/or corrosive chemicals.

[0002] A variety of submersible pumps have been used to perform in solutions, especially those containing strong chemical solvents. Unfortunately, prior art motor-driven pumps are often inefficiently designed and have short life expectancies because the highly corrosive environments are damaging to the pump body, motor, and/or seals of the pump. Thus, there is a need for a submersible pump that operates efficiently while reliably isolating the drive motor from the fluid in which the pump is submersed. There has further been a need to develop a pump that is electrically grounded suitably to prevent galvanic action on the pump components, including the pump housing. It is to these ends that the present invention has been developed.

[0003] The present invention addresses many of the needs mentioned above as well as other objectives that will be appreciated by those skilled in the art.

SUMMARY OF THE INVENTION

[0004] The present invention solves certain problems associated with motor-driven pumps that operate submerged in fluid or solutions, especially those containing strong chemical solvents. A new and improved motor-driven pump in accordance with the present invention provides important features including: (1) a highly chemical resistant body, (2) a shaft seal design for increased seal reliability and life expectancy of the pump unit; and (3) a grounding wire arrangement to electrically neutralize the environment in which the unit operates.

[0005] In accordance with one aspect of the present invention a motor-driven submersible pump is provided that includes an electric motor completely encapsulated in insulating and sealing material within a motor housing, the motor containing a rotating shaft extending to and drivingly connected to an impeller. The pump includes a motor cover fitted to the motor housing to enclose the motor, the motor cover being provided with a pour hole through which a non-conductive material may be poured to encapsulate the motor, an impeller housing that surrounds the impeller with an inlet and discharge outlet for fluid flow, and a seal between the motor cover and the impeller that prevents fluid from contacting the motor.

[0006] The present invention also includes an improved shaft seal arrangement for a pump comprising, a lip seal, a grease packing space and, in particular, an inexpensive self-aligning seal between the impeller cavity and a lip seal. The seal arrangement further includes a grease packing between the lip seal and the pump motor.

[0007] Those skilled in the art will further appreciate the above-noted features and advantages of the invention together with other important aspects thereof. Upon reading the detailed description which follows in conjunction with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] For a more complete understanding of the features and advantages of the present invention, reference is now made to the detailed description of the invention along with the accompanying drawing figures in which corresponding numerals in the different figures refer to corresponding parts and in which:

FIGURE 1 is a perspective view of the pump of the present invention immersed in a fluid-filled container;

FIGURE 2 is a front end view of the pump of the present invention;

FIGURE 3 is a side elevation of the pump of the present invention;

FIGURE 4 is an exploded view of the pump of the present invention;

FIGURE 5 is a section view taken along line 5-5 of FIGURE 2;

FIGURE 6 is a detail section view taken from the same line as FIGURE 5, but of a larger scale; and

FIGURE 7 is a section view taken from line 7-7 of FIGURE 5.

DETAILED DESCRIPTION OF THE INVENTION

[0009] Although making and using various embodiments of the present invention are discussed in detail below, it should be appreciated that the present invention provides many inventive concepts that may be embodied in a wide variety of contexts. The specific aspects and embodiments discussed herein are merely illustrative of ways to make and use the invention, and do not limit the scope of the invention.

[0010] In the description which follows like parts are marked throughout the specification and drawing with the same reference numerals, respectively. The drawing figures are not necessarily to scale and certain features may be shown exaggerated in scale or in somewhat generalized or schematic form in the interest of clarity and conciseness.

[0011] Additional objects, advantages and novel features of the invention as set forth in the description, will be apparent to one skilled in the art after reading the following detailed description or may be learned by practice of the invention. The objects and advantages of the invention may be realized and attained by means of the instruments and combinations particularly pointed out here. Those skilled in the art will recognize that other modifications and substitutions may be provided with respect to the invention disclosed herein without departing from the scope and spirit of the appended claims

[0012] Referring to FIGURE 1, there is illustrated a motor-driven pump 10 of the present invention submersed in a fluid-filled container 50. The motor-driven pump 10 comprises a motor housing 12, a motor cover 14, and an electrical conductor fitting 18. The motor housing 12 may be of a generally rectangular box-like shape and is preferably formed of a highly chemical resistant material, such as stainless steel. The motor cover 14 is secured to the motor housing 12 by cooperating latches 38, two shown in FIGURE 1, formed on the motor cover, placed generally in the center of each of the four sides of the motor cover and which will be described in further detail herein. Latches or fingers 38 cooperate with projections 39, see FIGURE 5 also, formed on housing 12 to provide

for snap fitting the motor cover 14 to the housing 12. The peripheral edge of housing 12 fits in a cooperating groove formed on motor cover 14, FIGURE 5. The motor cover 14 further includes a generally cylindrical boss 16 and a spaced apart closable pour hole 20 which is closed by a fluid tight cover 62.

[0013] The pump 10 further includes an impeller housing 22, and an impeller cover 24 including a fluid inlet conduit 26. Housing 22 further includes a fluid discharge conduit 28. Conduit 28 is preferably connected to a further conduit 28a for delivering fluid to its end use. The inlet conduit 26 is preferably integral with the impeller cover 24, while the discharge conduit 28 is integral with the impeller housing 22. The motor cover 14 and certain other components, including housing 22 and cover 24 are preferably made of chemical resistant plastic, such as Acetal. The boss 16 on the motor cover 14 includes a surface 17, FIGURE 5, adjacent which a gasket 30 lays between the boss 16 and the impeller housing 22. The impeller cover 24 is preferably affixed to the impeller housing 22 by stainless steel screws 32, at least at three points, as shown, see FIGURE 2 also.

[0014] A jacketed, multi-conductor, electrical power supply cord 40 is attached to motor-driven pump 10 through the fitting 18 to provide the electrical power for the pump 10. A fluid tight cord receiving conduit, not shown, may be connected to fitting 18 at threaded boss 18a. When submerged in the liquid, the motor-driven pump 10 may be mounted to the fluid-filled container 50 or allowed to stand alone within the container. Liquid from within the fluid-filled container 50 enters the pump through a strainer or screen 52 and the inlet conduit 26, flows through the impeller housing 22 and out through the discharge conduit 28 which may be connected to additional conduits, such as conduit 28a shown in FIGURE 1.

[0015] Now referring to FIGURE 2, there is depicted a front view of the present invention showing the strainer or screen 52 mounted on the inlet 26 to prevent foreign particulates from entering the impeller housing 22. The screen 52 may be formed on a threaded hub 53, releasably secured to inlet conduit 26. Pump 10 may be mounted on a right angle shaped bracket 54, as shown in FIGURES 1 through 5, by fasteners 32.

[0016] The electrical supply cord 40 is preferably for supplying 115 Volt, 60 Hertz, power to pump 10. In the preferred embodiment of the present invention, the

electrical supply cord 40 extends through and is in fluid tight sealing relationship with fitting 18.

[0017] Moreover, the pump drive motor is suitably encased within the motor housing 12 and is completely isolated from fluid surrounding the pump or within the impeller housing 22. Further description of the encasement features is presented below.

[0018] Now referring briefly to FIGURE 3, there is depicted a side view of the motor driven pump 10 of the present invention showing the optional angle bracket 54 that may be used to mount the pump in a fluid-filled container, or for other purposes or arrangements.

[0019] Referring now to FIGURES 4 and 5, FIGURE 4 is an exploded view showing the parts of the pump 10, and FIGURE 5 illustrates the parts assembled, some of which are sectioned. An electric motor 78 provides the motive force for the pump 10 of the present invention. The motor 78 is disposed within the motor housing 12, and includes an output shaft 72 drivenly connected to a rotor 80 suitably supported in opposed bearing housing members 82 and 84. Motor 78 includes conventional, field laminations 81 for rotor 80. Shaft 72 is preferably cylindrical and supports pump impeller 60 thereon, preferably by an interference fit.

[0020] An improved shaft seal arrangement is provided to protect the motor 78 encased in the motor housing 12 from fluid moved by the impeller 60 and within the impeller housing 22. First, the motor 78 includes a member comprising a generally cylindrical projection or motor bracket 68 that immediately surrounds the impeller shaft 72 and projects through a bore 16b, FIGURES 5 and 6, in snug or press fitted relationship. A cavity 67 in bracket 68 is packed with a suitable moisture barrier material, such as grease 69, see FIGURE 6, also. A fluoroelastomer double lip seal 66, FIGURES 5 and 6, is journalled by the bracket 68 by being disposed snug fitted in an enlarged bore 71 in the bracket. A flexible sheet-like self-aligning lip seal 64 is interposed a face 68a of bracket 68 and gasket 30 that abuts a surface 22a of impeller housing 22, FIGURE 6. The impeller 60 is disposed within cavity 23 of the impeller housing 22. The impeller cover 24 is fitted with an o-ring 58 engageable with the impeller housing 22. Plural countersunk screws 35 secure the impeller housing 22 to the motor cover 14, as shown in FIGURES 5 and 6.

[0021] Motor cover 14 is a generally rectangular member with generously radiused corners and with a perimeter, depending flange 14f, FIGURES 1 and 5, which defines, in part, a perimeter groove 14g, FIGURE 5, for receiving a perimeter rim 12r of housing 12. Cover 14 includes opposed, resiliently deflectable fingers comprising the latches 38, FIGURE 5, which are of relatively slim width and formed on opposite sides of cover 14. The fingerlike latches 38 are engageable with the opposed cooperating inwardly facing projections 39 formed in the side and end walls of housing 12. Motor cover 14 and housing 12 are dimensioned to be snap fitted together in substantially fluid tight engagement thanks to the latch means provided by the fingers 38 and projections 39. Motor cover 14 is further provided with four, opposed, arcuate flanges 14e, FIGURES 4 and 5, which aid in locating and supporting the motor cover with respect to the housing 12.

[0022] The motor 78 is further protected from fluid by an encapsulation process. Here, a protective encapsulating material is caused to flow into the interior space 12s defined by the motor housing 12 and the motor 78 and to totally encapsulate motor 78. The protecting encapsulating material, not shown is added through the pour hole 20. The pour hole 20 is then capped with fitted pour hole cover 62, secured by adhesive, for example.

[0023] Generally, the encapsulation process includes adding a non-conductive encapsulating material, such as black epoxy, using methods known to one of ordinary skill in the art.

[0024] To electrically neutralize the environment in which the motor-driven pump 10 operates, an improved grounding wire arrangement is provided in accordance with the present invention. The generally rectangular box shaped stainless steel motor housing 12 has been incorporated into the grounding design. As shown in FIGURES 2 and 5, a first ground wire 74 is attached to motor 78, such as at the bearing housing member 84 of the motor, and includes a connector 74a which is connected via solder or welding to bottom wall 12a of the motor housing 12 near the electrical fitting 18. A second ground wire 76 is also connected to bottom wall 12a of the motor housing 12 at a connector 76a also near the electrical fitting 18 but spaced apart from the point of connection of wire 74 to wall 12a, as shown in FIGURE 2, and substantially across the width of housing bottom wall. The second ground wire 76 is included in the electrical power supply cord 40. This

arrangement provides superior cancellation of galvanic effects on the pump and prevents exterior portions of the pump e.g., motor housing 12, motor cover 14, pour hole lid 62, external screws, as well as the impeller 60, seal 66 and screen 52, from deteriorating and/or corroding as a result of galvanic effects.

[0025] Referring further to FIGURES 5 and 6, there is depicted a complete assembly view of the present invention, as shown in FIGURE 5. FIGURE 5 illustrates how the impeller 60 is provided with a central bore 60b, is fitted in the impeller housing 22 within cavity 23 and is press fitted onto the impeller shaft 72. FIGURES 6 and 7 illustrate further the configuration of the open style centrifugal impeller 60, having four equally spaced radial blades 60a. The impeller 60 draws fluid from inlet conduit 26 generally into the center of the cavity 23 of the impeller housing 22 whereby fluid is expelled in a radial direction therefrom, exiting out the discharge outlet 28.

[0026] The multistage seal arrangement in the pump 10 of the present invention is particularly important in protecting the pump from failure. As shown in FIGURES 5 and 6, the multistage seal comprises the self-aligning lip seal 64, formed of a flexible sheet of, for example, Rulon J, Rulon 123 or Rulon 1045; a fluoroelastomer double lip seal 66 that may be of a type commercially available; and a moisture barrier. Self-aligning lip seal 64 is placed between gasket 30 and the fluoroelastomer seal 66 to self-align with the impeller shaft 72. A moisture barrier 69 is preferably inserted between the lips of the fluoroelastomer seal 66 and within cavity 67, FIGURE 6, of motor bracket 68. Moisture barrier 69 also helps to reduce friction between impeller shaft 72 and the lips of the fluoroelastomer seal 66. This overall seal arrangement results in a long life expectancy of motor 78.

[0027] As further shown in FIGURES 5 and 6, a space 23s between the impeller 60 and backwall 22b of impeller housing 22 functions to reduce fluid pressure on the self-aligning seal 64 to further reduce wear and increase its life expectancy. Sheet-like, self-aligning lip seal 64 includes a slightly undersize bore 64b, FIGURE 6, so that when seal 64 is placed over shaft 72 a frustoconical lip portion 64a develops which is in substantially fluid tight engagement with shaft 72 and is disposed generally in a bore 22c of housing 22. The molding of self-aligning lip seal 64 about the impeller shaft 72 provides an improved seal of proven long life. In total, the design provides a seal against

the exterior of the rotating shaft. Further, the seals 64 and 66 may be readily replaced, if required.

[0028] An example of an assembly procedure is further described herein. For the wiring, the motor housing 12 is placed into an assembly fixture (e.g., nylon assembly fixture; not shown) followed by the placement of a threaded electrical conductor fitting 18 into the motor housing 12. Onto the threaded electrical conductor fitting 18 an adapter gasket and an adaptor nut is threaded and tightened. The terminated ends of an electrical supply cord 40 are placed through the threaded electrical conductor fitting 18 and into the motor housing 12. The ground lead 76 of the electrical supply cord 40 is connected to the grounding terminal connector 76a inside the motor housing 12 (e.g., at the bottom wall 12a) as further described with FIGURES 2 and 5. The motor cover 14 is press fit onto the motor 78 at boss 68 (by hand or by machine) and ground wire 74, which may be previously connected at connector 74a to motor housing 12, is connected to the motor housing 12, such as at the bearing housing member 84. The main and common leads of the electrical supply cord 40 are then connected to the motor 78. Motor cover 14 is then fitted onto the motor housing 12 (e.g., by hand) and the unit is then removed from the assembly fixture in preparation for the encapsulation process.

[0029] For epoxy encapsulation, the pump 10 may be placed on an epoxy oven conveyor and filled with a non-conducting encapsulation material, such as black epoxy, through pour hole 20. Additional epoxy may be dispensed to "top off" the encapsulation process. After epoxy encapsulation (e.g., epoxy curing), testing of pump 10 may be performed.

[0030] For final assembly of the motor-driven pump 10, a fluid tight cover 62 is placed (press fit) over pour hole 20. The flexible sheet-like self-aligning lip seal 64 is pressed over output shaft 72 and further pressed down until it contacts motor cover 14. Over the flexible sheet-like self-aligning lip seal 64 and onto the output shaft 72 is placed gasket 30 after which the impeller housing 22 is placed on the motor cover 14 by inserting four screws 35 through the impeller housing and onto motor cover 14. The impeller 60 is then pressed onto the output shaft 72 (this may be performed using a nylon fixture base and an impeller press) followed by fitting the o-ring 58 engageable with the impeller housing 22 and securing with impeller cover 24, aligning all holes for entry of stainless steel screws 32. When optional angle bracket 54 is required, it may be placed

over impeller cover 24 aligning all mounting holes. In either case, screen 52 is further placed upon impeller cover 24 and formed on a threaded hub 53, releasably secured to inlet conduit 26.

[0031] Except as otherwise described herein, the pump 10 may be fabricated using conventional engineering materials and practices known to those skilled in the art.

[0032] Additional objects, advantages and novel features of the invention as set forth in the description, will be apparent to one skilled in the art after reading the foregoing detailed description or may be learned by practice of the invention. The objects and advantages of the invention may be realized and attained by means of the instruments and combinations particularly pointed out here.